

# A $\sim 14$ DAYS STAR WITH TWO PHASE-LOCKED MODES OF PULSATION IN THE EROS DATABASE

*in Variable stars and the astrophysical return of microlensing surveys,  
ed R. Ferlet, J.P.Maillard, éditions frontières.*

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## Abstract

Using CCD photometry obtained by the EROS collaboration in 1991-1993, we have discovered an LMC variable star with a light curve that is oscillating with a mean period of  $\sim 14$  days and an amplitude of  $\sim 0.3$  mag. The oscillations appear with irregular amplitude variations. The Fourier spectrum shows that the pulsation of this star is phase locked between two modes of frequencies  $f_0$  and  $1.5 \times f_0$ . Moreover, this object has strong  $H\alpha$  and  $H\beta$  emission lines and neutral lines of Helium that suggest a spectral type between late O and early B. In a preliminary analysis, we derive a luminosity of  $L = 3.4 - 3.8 L_\odot$  and an effective temperature in the range  $\log(T_{eff}) = 3.85 - 4.2$ .

## 1 Observations

CCD photometry was obtained in a field of 0.5 square degree in the bar of the LMC between 1991-1993 for EROS. About 2500 images spanning  $\sim 130$  days were taken in two broad bandpass filters  $B_E$  and  $R_E$  centered respectively on 490 and 670 nm in the 9192 campaign, and 5500 images were taken of the same field with a pair of very similar filters ( $B_{E2}$ ,  $R_{E2}$ ) for the 1992-1993 campaign. We have systematically searched the EROS database

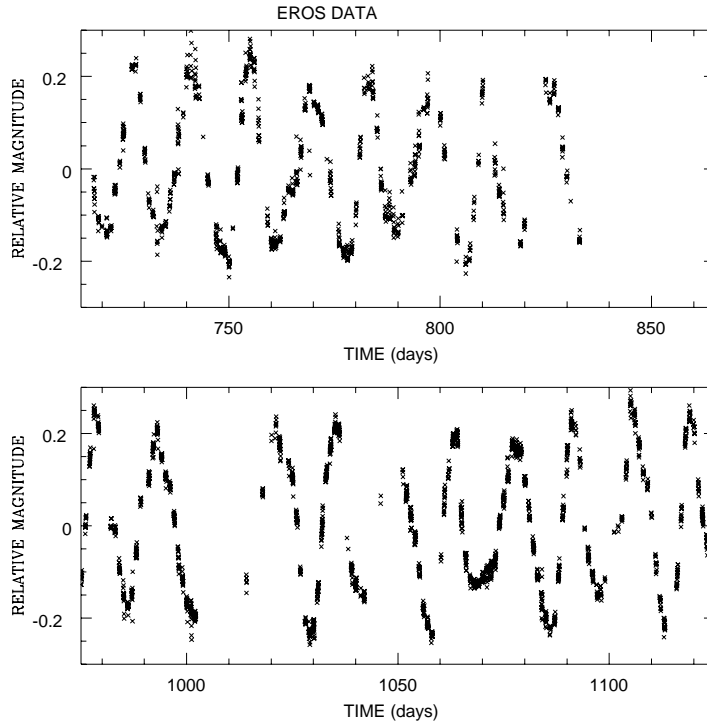


Figure 1:  $B_E$  light curve from 1991-1992, and the beginning of 1992-1993 campaign.

for variable stars using the modified periodogram technique[4][1] and the AoV method[7].

Among the hundredth detected variable stars, we have discovered a bright LMC variable star ( $\alpha = 5h18m10.5$ ,  $\delta = -69^035m59$ , equinox 2000.0) with a 'period' of  $\sim 14$  days and a particular behaviour, a clear alternance between cycles with larger and smaller amplitudes (Fig 1). A Fourier fit with 8 independent frequencies leads to a spectrum with two dominant frequencies at  $f_0=825.69$  pHz and at  $1.5003 \times f_0$  (Fig.2). This suggests that the pulsation of this star is phase locked between two modes of frequencies  $f_0$  and  $1.5 \times f_0$ .

From the photometry, assuming different values of reddening ( $E(B-V) = 0.10-0.30$ ) and applying the temperature scale from Kurucz's atmospheric models, we estimate the effective temperature of the star to be in the range

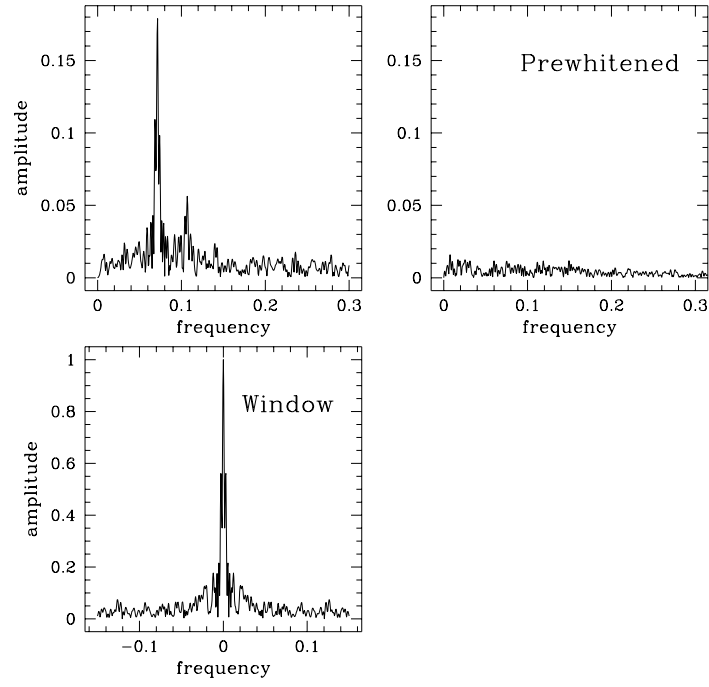


Figure 2: Fourier spectrum of the 1991-1993 light curve, of the prewhitened light curve in which the two frequencies  $f_0$  and  $f_1$  have been removed, and the spectral window. Notice the power around 0.07 (fundamental frequency), and the secondary peak around 0.11.

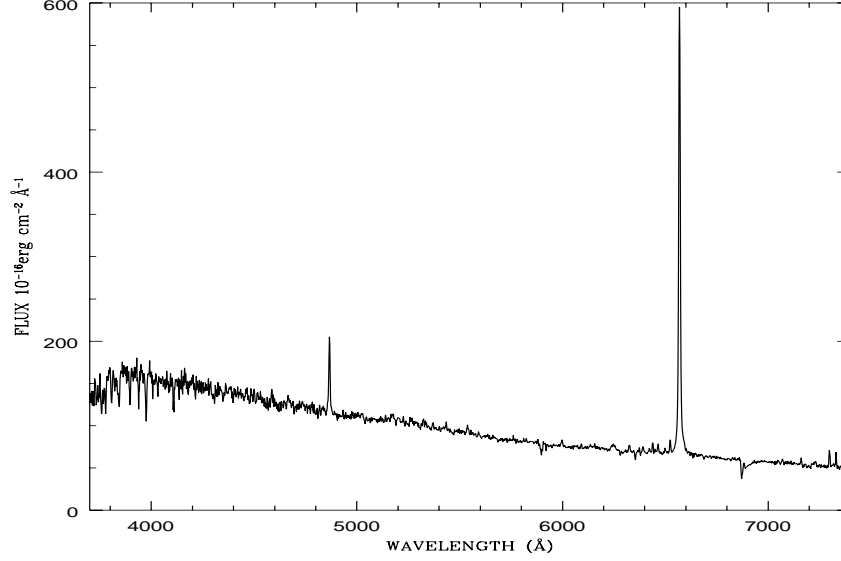


Figure 3: Low resolution spectrum of the object.

$\log(T_{eff}) = 3.85 - 4.2$ .

The apparent magnitude of the star is  $V_J = 13.60$ . Assuming a distance modulus to the LMC of  $\mu_{LMC} = 18.5$  mag, and a bolometric correction in the range  $-0.3, -2$ , we derive a luminosity in the range  $L = 3.4 - 3.8 L_{\odot}$ .

Low resolution spectroscopy in the wavelength range  $3700 - 7000 \text{ \AA}$  has been obtained at ESO la Silla in December 1995 with the ESO 1.5m equipped with a Boller and Chivens spectrograph. The resolution was  $7 \text{ \AA}$ , and we get a signal to noise ratio of 50 at  $6000 \text{ \AA}$ . This star belongs to the LMC. Its spectrum shows strong  $H\alpha$  and  $H\beta$  emission lines, and neutral lines of Helium indicating a spectral type between late O and early B (Fig 3).

Further observational information are :

- (1) This star is located in the same area in the bar of the LMC, where 7 pre main sequence star candidates (PMSC) have been found[2].
- (2) It presents strong Balmer emission lines (equivalent width of  $91 \text{ \AA}$  for  $H_{\alpha}$ ).
- (3) Its colour and spectrum suggest a spectral type between late O and early B.
- (4) We have no evidence for the presence of an extended  $HII$  region around

this object.

(5) It is brighter than the PMSC which we discovered in the LMC.

(6) It presents an irregular photometric variability with a time scale of  $\approx 14$  days. However, the photometric variability seems to be due to a two mode phase-locked pulsation. The observed large amplitude leads to favour a radial pulsation rather a non-radial one.

Based on these arguments, we suggest that this star can be a pre main sequence object or a post-AGB star. A companion poster [6] examine the possible nature of this object by means of a linear stability analysis of hydrostatic envelopes, and computations of hydrodynamical models.

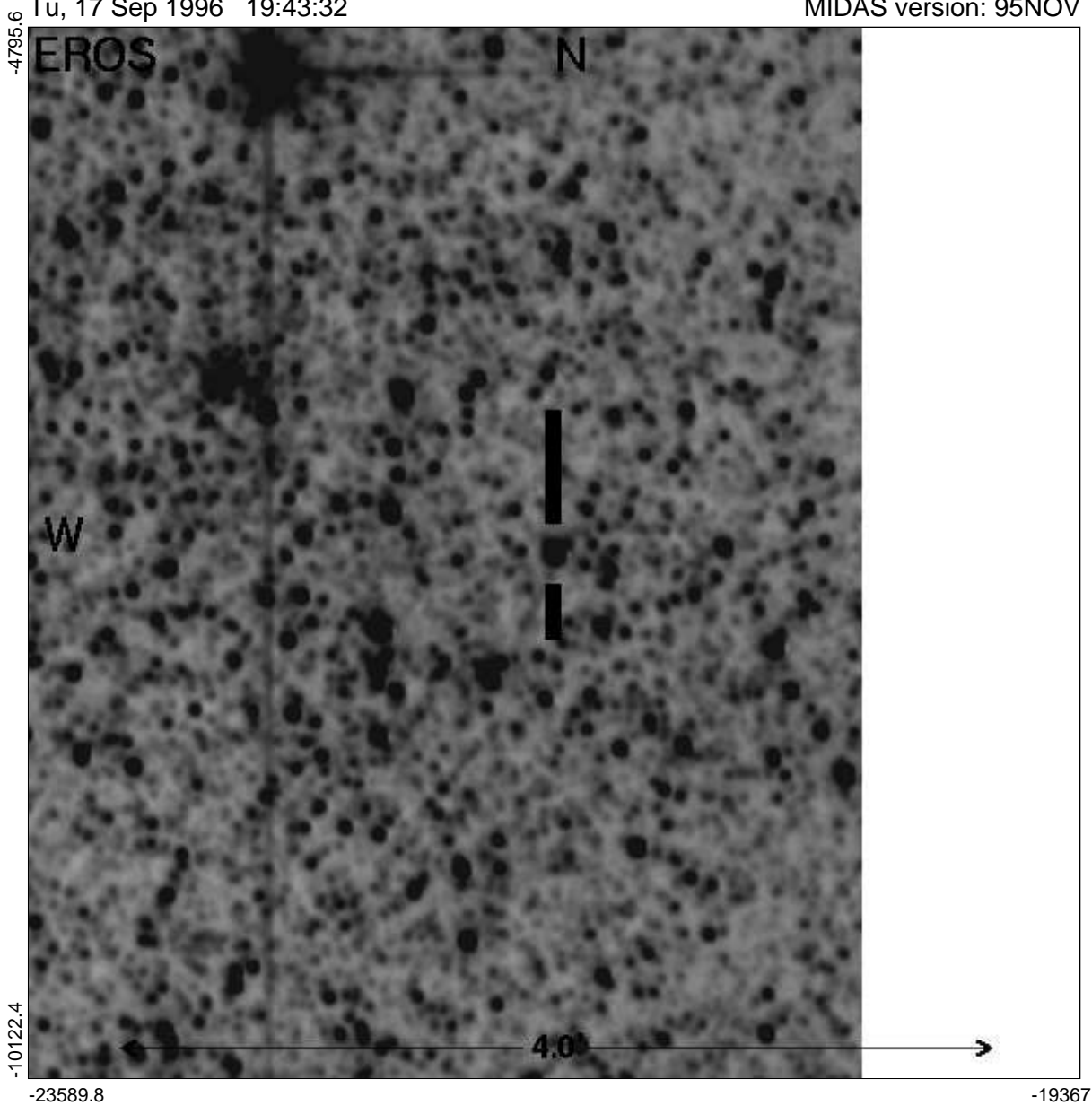
acknowledgements : This work has been supported by IFT at the University of Florida, CNRS DASGAL, the IAP and NSF, and is based on observations held at ESO La Silla.

## References

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Tu, 17 Sep 1996 19:43:32

MIDAS version: 95NOV



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Cut values : 50, 200  
User : beaulieu